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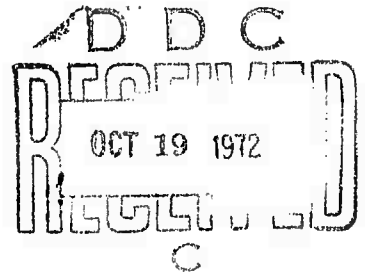


CENTER FOR COMPUTER-BASED BEHAVIORAL STUDIES

The Regents of the University of California

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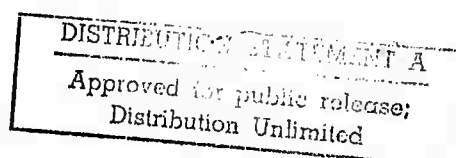
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## 13. ABSTRACT

The Center for Computer-Based Behavioral Studies (CCBS) on the UCLA Campus is designed and is being developed to overcome a number of the methodological limitations blocking significant research advances in, and behavioral sciences' contributions to, the study of national policies and problems. The Center is designed around a time shared computer system that will make its informational and technological resources available to behavioral scientists and policy analysts located at widely dispersed university and government research centers, offering them new and powerful research, policy planning, and educational tools. A number of these tools for studying and analyzing the behavior of individuals, groups, and social-political units are specifically capable of narrowing the enormous gap that continues to exist between the policy analyst and the behavioral scientist. Essential to the development of these broad methodological and technological areas is an ongoing program of substantive research on bargaining and conflict resolution behavior relevant to political crisis management. As the three areas of development (laboratory gaming and simulation research, inductive data analysis, and data resources management) share a systematic base of operation, the potentials for mutual support among them will be substantially enhanced. Central to all of these activities are plans based on a number of highly integrated software system, hardware configurations, and laboratory design and equipment requirements, stemming from ARPA- supported research and development projects conducted over the past seven years.

DD 1473 Abstract continued from page 1

This document describes project developments covering the first three years placing particular emphasis on progress covering the last six month period and on plans for project developments for the balance of the contract period. As an aid to the reader who may not have past documentation close at hand, the document as a whole, and many of the internal sections, are prefaced by an overview statement which reflects the general background and rationale developed in the original proposal.

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**CENTER FOR COMPUTER-BASED BEHAVIORAL STUDIES**

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## PUBLICATION REVIEW

This technical report has been reviewed and is approved.

*Al de Lucin*  
RADC Project Engineer

## TABLE OF CONTENTS

	Page
ABSTRACT.....	iiii
OVERVIEW OF THE REPORT.....	1
PROGRESS ON PROJECT: 1 JULY 1969 THROUGH 30 JUNE 1972.....	5
Computer laboratory developments.....	6
Computer hardware.....	6
Computer software.....	10
Laboratory software.....	13
Data management and analysis.....	15
TRACE--data management developments.....	16
IDEA--inductive analysis developments.....	16
Laboratory facilities.....	18
Simulation research and methodology development.....	19
Scenario topics, conceptual issues, and scenario developments.....	20
Experimental and para-laboratory research studies of human behavior in situational conflict.....	30
FUTURE PLANS.....	36
PROFESSIONAL AND PROJECT-RELATED ACTIVITIES.....	41
PROJECT DOCUMENTATION, JANUARY - JUNE 1972.....	44



## ABSTRACT

The Center for Computer-based Behavioral Studies (CCBS) on the UCLA Campus is designed and is being developed to overcome a number of the methodological limitations blocking significant research advances in, and behavioral sciences' contributions to, the study of national policies and problems. The Center is designed around a time-shared computer system that will make its informational and technological resources available to behavioral scientists and policy analysts located at widely dispersed university and research centers, offering them new and powerful research, policy planning, and educational tools. A number of these tools for studying and analyzing the behavior of individuals, groups, and social-political units are specifically capable of narrowing the enormous gap that continues to exist between the policy analyst and the behavioral scientist. Essential to the development of these broad methodological and technological areas is an ongoing program of substantive research on bargaining and conflict resolution behavior relevant to political crisis management. As the three areas of development (laboratory gaming and simulation research, inductive data analysis, and data resources management) share a systematic base of operation, the potentials for mutual support among them will be substantially enhanced. Central to all of these activities are plans based on a number of highly integrated software systems, hardware configurations, and laboratory design and equipment requirements, stemming from ARPA-supported research and development projects conducted over the past seven years.

This document describes project developments covering the first two and one-half years placing particular emphasis on progress covering the last six-month period and on plans for project developments for the balance of the contract period. (As an aid to the reader who may not have past documentation close at hand, the document as a whole, and many of the internal sections, are prefaced by an overview statement which reflects the general background and rationale developed in the original proposal.)

## OVERVIEW

The events of the sixties have underscored the general failure of the behavioral sciences to contribute significantly to the solution of the pressing problems of the day, or to offer guidance to the decision makers who face these problems. In the outspoken view of a national advisory committee on the behavioral sciences, there is a "lack of vital social and economic information on critical issues and lack of methods for analyzing information and relating it to policies and operations."\*

While there is a growing recognition of the relevance of the behavioral sciences to the range of complex decisions facing the government in domestic and foreign affairs, it has not immediately produced a new wave of social science research. The university scientists of the country have moved slowly in facing these large-scale problems. Part of their reticence stems from the realization that new research directions require new methods and information resources that are beyond the capabilities of individual researchers within most university research communities.

This document describes the plans for a Center for Computer-based Behavioral Studies (CCBS) on the UCLA Campus--its design, phased development, and use. The Center is designed around a time-shared computer system that will make its informational and technological resources available to behavioral scientists located at widely dispersed university and research centers, offering them new and powerful research, policy planning, and educational tools. The Center will provide resources that will allow behavioral scientists to extend their knowledge and basic research interests to the study and analysis of national policies and problems. A number of these tools for studying and analyzing the behavior of individuals, groups, and social-political units are specifically relevant to

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\* "Report on the Behavioral Sciences and the Federal Government," American Psychologist, 23:11 (1968), p. 803.

help bridge the enormous gap that continues to exist between the policy analyst and the behavioral scientist, who prefers to engage in those forms of research which yield more readily to reductionist theories and existing research techniques.

The broad range of needed support can be cast into three generally defined areas:

- Laboratory Gaming and Behavioral Simulation Research. The aim is to provide necessary laboratory techniques so that problems embedded in real-world complexity can be studied intensively and rigorously in a controlled laboratory environment. A laboratory program is designed to break through some of the methodological limitations that currently threaten the viability of laboratory simulation for use as a tool in both theory building and policy study. A variety of laboratory techniques will be developed for using the computer as an experimental tool for on-line analysis, umpiring, controlling, and recording of decision-making behavior, particularly the dynamic interaction process that takes place between players and teams of players. A primary focus of such development will be to provide support for complex, multiperson simulations.
- Inductive Data Analysis. The need is to develop more effective tools for exploratory and inductive analysis of data that are not well understood and that may be derived from situations that do not fit the tightly structured paradigms of traditional research designs. As the sources of data become larger, more complex, and more open-ended (whether from the growing role of induction in laboratory studies or from the increased use and availability of real-world data archives), the researcher will need new means of exploring, manipulating, and analyzing these data.
- Data Resources Management. The need is to develop a data resource system and associated data repository to be based on the most advanced computer analysis and data management techniques, including new procedures for information retrieval and archive maintenance. The technology we have developed for on-line data management and data analysis could provide many of the building blocks for a system to satisfy the interactive requirements and archive management for a large number of users with diverse interests. Such a system could become much more than an improved archive management capability--it could develop into a major extension of the methods of scientific communication: In addition to retrieval and analysis, many of the informal procedures surrounding the communication of ideas and data could be incorporated explicitly into the system.

Specifications for these capabilities would be established by an assessment of the needs of behavioral scientists, policy analysts, and planners and by pilot studies on existing data archives.

A common requirement for each of these proposed developments is the need for a large-scale, time-shared computer system. With the three areas of development sharing a common and systematic base of operation, the potentials for mutual support among them would be materially enhanced.

As the discussion in the next section will demonstrate, the support offered by powerful inductive analysis tools could reduce the constraints on the experimental design and data collection in simulation and gaming research; in turn, the research data collected could serve as a generating source for guiding the on-going development of the data analysis system. Laboratory research would also be supported by a data resource system having ready-made, on-line data banks available for participants in real-world simulations; in turn, the information demands of decision makers in realistic experimental contexts could help delineate the operational requirements for the form, content, and service demands of the data resources system. Finally, and perhaps most obviously, the data analysis system would augment the data archive management functions with tools for analysis and evaluation. These do not, of course, exhaust the possibilities of mutual support; others, not now identified, will undoubtedly emerge from the demands of use where the common base of operation makes such demands reasonable.

In the most practical terms, a pivotal consideration is the projected success of a research center should be its actual and perceived utility to the behavioral science community. The more closely the support developments are related by demonstrable usefulness to on-going research, the greater the likelihood that the center will be genuinely useful and used. This principle, which seems so obvious, is often lost in the process of formulating and designing research support systems. This happens in part because system users and system producers generally represent

distinct groups in terms of interest and/or experience; as a consequence, highly technical and readily identifiable demands of computer and software implementation tend to take precedence over the less compelling needs of application. A practical and direct remedy for this is to make sure that the developers of the requirements of the research center are also among the major users. This strategy is incorporated into the Center.

The initial specifications of requirements were derived largely from our past project efforts to extend behavioral research to policy relevant areas through the use of computer capabilities. Since the technological, methodological, and data analysis specifications have all grown directly out of the practically perceived needs of a substantive research program, there is a high guarantee of utility that could not otherwise be derived. For on-going developments, this close operational association between in-house, substantive research projects and resource support programs is to be continued. For the area of data resource utilization, where the requirements are less well defined, we plan to rely more heavily upon those associations, groups, and individuals who constitute the major users of data resource systems.

## Background and Summary

Progress during the first twelve months of the project was severely curtailed by protracted contractual negotiations; a definitive contract was not implemented until the last week of the first year. A finalized contract was established the last week of June 1970.

In sum, the project operated for the entire first year without the enablement of a finalized contract, and without authorization to acquire the central computing system and its major components of hardware and software support. Additionally, during the first half of the year nearly all planning and preliminary steps toward implementation had to be deferred until the decision on the central computer configuration was resolved. In the absence of enabling conditions--without definite selection of the central processing system and without contractual authority to purchase major equipment, to subcontract for software development, or to develop project staff--the proposed schedule of development for the first year was critically compromised.

In contrast, the project progressed at an accelerated rate in the next two years; as a result, we have been able to recoup a significant portion of the schedule slippage due to first-year delays. Phase I of the computing system is essentially complete, both with respect to hardware configuration and operating system software. Phase II hardware and software design has been developed through a detailed design stage; we are ready to undertake steps for implementation. Two higher-order programming languages--JOVIAL and META--have been developed; both META and JOVIAL are now being used for applications programming. We have developed a programming system that provides rapid and easy laboratory implementation of experimental research designs. In data management and analysis, we have implemented (a restricted version of) TRACE, a system that essentially provides implicit programming capabilities in data analysis; and we have implemented a fully interactive version of IDEA,

a program that provides computer assistance in the task of inductive data analysis. The construction of permanent laboratory facilities is complete. CCBS is being interfaced with the ARPA network as a means of offering our capabilities to a wider community of users. In sum, the overall project development is still behind the schedule originally proposed, but considerably less so than might be expected with the first-year delays.

### Computer Laboratory Developments

The principal goal of the project is to broaden and expand the capabilities of behavioral research, particularly in areas of potential policy relevance. The principal means of accomplishing this goal is to develop new behavioral research methodologies through the use of on-line, data acquisition tools, particularly for computer-administered experiments and simulations and for interactive forms of data and text analysis. The goals of the project, then, are predicated on the development of a large-scale time-sharing computing system.

### Computer Hardware

The hardware configuration of the CCBS central system computer is designed to support high-speed interaction with many concurrent users who, in the three primary applications of the system, may be any mix of experimental subjects, data analysts, and development programmers. The different applications (and associated different types of users) require different interactive service needs, which, in sum, present a need for greater than normal communications processing. The basic hardware configuration is especially designed to meet these requirements.

Beyond the basic configuration, the major extension of computer hardware is to meet extended data management requirements, especially as these relate to the management of data bases of archive proportions. (This aspect of the project is identified

in the original proposal as Phase II development.) There are two major facets in extended data management capabilities: First, a need to provide greater data storage capacity in the system, and, second, a need to provide improved means of accessing when it resides outside the normal bounds of direct addressability (i.e. core memory). The first of these requirements is being met with the acquisition of additional standard disc storage. There is, by contrast, no standard hardware available for meeting the second requirement; we have therefore undertaken the development of hardware and associated software necessary to support virtual memory programming.

A summary of the computer system hardware is given below:

CCBS computer system hardware, basic configuration:

Processor: DEC PDP-10/PDP-15 dual processor--both processor interface to PDP-10 core (262,144 words of 36-bit, 1.5  $\mu$ sec. memory) with 4192 words of 18-bit, 0.8  $\mu$ sec. memory on the PDP-15; interprocessor memory interface, DA15-C, developed by DEC (detailed description in Appendix B, Technical Report 12/31/70); and high speed communications interface, developed by DEC (detailed description in Appendix C, Technical Report 12/31/70). An additional 8192 words of memory has been ordered for the PDP-15 to support ARPA Network operations. Virtual memory hardware is under development that will permit most of the instructions on the PDP-10 to reference directly over 8 billion words of storage.



Auxillary storage devices on the PDP-10:

- Drum: 2 swapping drums. DEC RM10B (storage capacity of 345,600 words each, mean access time of 8.3 msec., and transfer rate of 4.1  $\mu$ sec. per word).
- Disc: 4 disc-pack drives. DEC RP02 (storage capacity of 5.2 million words per pack, mean access time of 62.5 msec., and transfer rate of 15  $\mu$ sec. per word). One DEC RP03 has been ordered (storage capacity of two RP02 drives with equivalent performance).
- DECTAPE: 6 drives, DEC TU56 (storage capacity of 367 thousand characters per tape, mean access time of 10 seconds, and transfer rate of 15,000 characters per second).
- Tape: 2 drives--one 7-track industry standard, DEC TU20B (45 in./sec., density to 800 bpi.); One 9-track USASI standard, DEC TU20A (45 in./sec., density at 800 bpi.). One 9-track TU10 has been ordered (performance is equivalent to TU20A).
- Card: card punch, DEC CP10A (200 cards per minute) card reader DEC CR10A (1,000 cards per minute).

Auxillary storage devices on the PDP-15:

- Disc: 1 fixed head track. DEC RS09 (storage capacity of 262,144 18-bit words, mean access time of 16.7  $\mu$ sec., and transfer rate of 16  $\mu$ sec. per word.)

Printer Plotter: Gould, model 55-5032-100--text and graphics;  
96 printable characters; print rate: up to 1000 lines per minute for a 132-character line access on 11-inch. page, processor-limited.  
Plot rate: up to 8 inches per second for 11-inch wide plots, processor-limited.

Communication terminals:

- High-speed terminals: 24, Computek Model 400/15; storage tube; text/graphics display, keyboard and light-pen\* input; 96 printable characters; transmission rate: 7200/300 baud.
- Hard copy terminals: 5, Texas Instrument Model 720; 95 printable characters; transmission rate: 300/150/110 baud.

The system described above is essentially complete--except for the items indicated as being on order or under development, all components have been acquired and are operational.

Two major modifications to the hardware system are underway in the areas of data storage and data management:

Extended data storage capacity--disc storage is being augmented in two ways: public disc storage will be increased by the addition of an additional disc drive (DEC RP03 which offers double the storage capacity of the RP02), permitting some of the existing, smaller capacity RP02 drives to be allocated for use with private disc packs. A modification to the disc controller is required to permit it to handle both RP02s and RP03s. An additional 4-track tape drive will be used to provide automatic off-line backup to disc storage when disc utilization nears capacity.

Extended data management--the hardware necessary to support virtual memory programming is being developed by CCBS; the design concept has been implemented by software simulation (the SMART system described below); a design study of the virtual memory hardware has been completed, and detailed documentation and logic design are being generated in prepara-

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\* Light-pens for the Computek terminals have been developed jointly by Computek and CCBS in response to CCBS needs; development is the first light-pen capability for a remotely located storage-tube display terminal.

tion for hardware acquisition.

Accomplishments during the current reporting period relating to system modifications:

- Order of additional storage (disc drive and tape drive).
- Design of virtual memory hardware.

### Computer Software

Software developments are oriented toward on-line data acquisition techniques (currently planned computer-administered experiments and simulation) and interactive forms of data analysis. There are two major lines of development: General support and applications support--general support programming provides the software environment for application support programming which, in turn, provides the software-implemented methodology for the end-users in the system. Within the general support effort there are two areas of concentration: Operating system and higher-order languages. Within the applications support effort there are also two areas of concentration: Laboratory research and data analysis.

### Operating System Improvements

CCBS requirements for a time-sharing system are somewhat atypical--in particular CCBS users are typically not all one class, are not usually programmers, and are often not independently related to a given object program. In some respect each of the differences are at variance with assumptions that are built into standard time-sharing system supplied with the DEC PDP-10 computer. It has been necessary, then, to modify the operating system to CCBS needs. While none of these modifications are in the class of major technical innovations, and while none by itself constitutes a major revision, they are, on the other hand, non-trivial changes and represent, in sum, a significant programming effort. These modifications are listed and briefly described below:

Terminal interactions--all terminal interactions in the delivered DEC system assume continuous-scroll output; to match the display characteristics of the Computek terminals, terminal output had to be "paged". Additional changes were required to permit several terminals to be controlled by one program and to provide software control over the way the system supports the terminals.

Disc and tape access-- access to peripheral storage in the delivered DEC system is assumed to be a user responsibility with only minimal provision for system protection and assistance. To accommodate naive users, peripheral storage access procedures have been modified.

Device assignment-- in the delivered DEC system, the assignment of access devices for private data storage are assumed to be a user responsibility; again, to accommodate naive users the operating system has been modified to provide new procedures, better protection, and greater assistance in device assignment. These improvements are generally applicable to all PDP-10 systems; documentation is contained in TM-13.

(In addition to modifications of the operating system monitor, the manufacturer-supplied general utility programs also required extensive modification and augmentation.)

Terminal support-- the Computek terminals which serve as the primary interactive devices for the system are considerably more versatile than the normal devices upon which DEC utility programs are predicated; to fully utilize the versatility of the Computek terminals, the DEC utility programs had to be revised.

Text Editor--

two editors were delivered with the hardware; neither was considered adequate for the broad class of users in CCBS; a new text editor has been implemented; this editor is generally applicable for all PDP-10 systems; documentation is contained in TM-10, TXTED: A Simple Content Editor.

Beyond these modifications, a major revision of the operating system is planned. This revision is required for the development of an extended data management capability (i.e. the software side of developing virtual memory capability). As mentioned previously, the virtual memory design has already been simulated in a software version. The emulation of virtual memory hardware is part of the SMART system, but, in addition to emulating the virtual memory hardware, SMART also performs elaborate core management services; it is these core management services that constitute the planned operating system revisions. They will be incorporated into the time-sharing monitor after the virtual memory hardware is acquired. The core management concepts of the SMART system are described in P-4 SMART: A Multiple High Segment Executive System,

#### Higher-order Language Developments.

The CCBS research program imposes requirements on the type of higher-order programming languages that are needed to support the development of application systems. In particular, the computer-administered experimentation implies a need for programming forms that facilitate real-time process control, and interactive data analysis implies a need for programming forms that facilitate general data manipulation and management. When the PDP-10 computer was acquired, the higher-order languages available on the machine were evaluated for CCBS applications and were judged to be inadequate; a higher-order language development was required. A modified JOVIAL and META were selected for implementation--JOVIAL because it had a history of performance in both command-and-control

systems and data management, and META because it had proven utility both as an interface between JOVIAL and intermediate language forms (of the type contemplated in CCBS applications), and as a powerful, character-string manipulator (to aid in restructuring data bases).

Both JOVIAL and META are now operational in the CCBS system. Since both are programs of general utility for all PDP-10 systems, general releases are planned when the compilers have been shaken down and thoroughly documented. Experience with using both of these compilers in an interactive environment has demonstrated the need for improved on-line debugging aids that permit the user to communicate in the notation of the higher-order language source program. Such interactive debuggers have been defined both for JOVIAL and for META. A partial implementation of a META debugger has been developed and is now in use, resulting in a great reduction in time required to check out META programs. A contract has been let with Abacus Programming Co. for the incorporation of an interactive debugger into the JOVIAL system.

Accomplishments during the reporting period which relate to higher-order language developments are the following:

- Final delivery of the JOVIAL compiler.
- Completion of prototype META debugger.

#### Laboratory Software

On-line computer-administered experimentation is, for many behavioral researchers, a relatively unfamiliar method of investigation. They have had little or no experience with the process control programming even if they have used computers extensively for data reduction and analysis. They would, then, have difficulty using the laboratory without a considerable degree of assistance; the problem is analogous to using a computer without the assistance of high-order languages; the analogous need is to provide a "research-design compiler". CCBS has developed this sort of software

support in the form of a system of programs called LIS: Laboratory Implementation System. A more extended description of the general rationale of LIS is contained in P-1, LIS: An Implementation System for Computer-based Experiments. The total Laboratory Implementation System is composed of four programs described below:

- LIS--The central and major program in the system. The program handles all routing of information, evaluation of responses, presentation of displays, recording of data, and logic contingencies necessary for implementation of experiments. The base program is operational; shake down experience has substantiated the design concepts--for a broad set of applications we can produce a meaningful implementation in a matter of days. Since we have adopted a policy of incremental development, improved versions of the program are being produced continually.
- LSPEC--Laboratory Specifications Program. This program presents an interactive questionnaire to the user; responses to the questionnaire are the basis for generating formal specifications for a "first-cut" version of an experiment. The response-to-specifications is automated. The resulting specifications are sufficient to check-out the logic of the experiment; if modifications are required, the system offers an easy transfer to the LISED program (to make the necessary changes) and an easy transfer from LISED to LIS (to reflect the changes made). Iterations on this process permit the user to successively approximate his final research design. Elaboration of the display content is handled through DGP with comparably easy transfers between LIS and DGP.
- DGP--Display Generation Program. This program is used for preparing displays composed of straight-line graphics and alphanumeric information for use in experiments or for educational purposes. The procedures for preparing dis-

plays are conversational; the user language has been designed for a non-programmer, with operating instructions incorporated directly into the program. This program is now operational.

- LISED--Table Editing Program. LIS operates interpretively on a set of tables whose entries contain values defining a given experiment. The initial setting of these values into the tables is the most exacting and time-consuming procedure in the process of implementing an experiment; for any given experiment, this is a one-time task almost exclusively clerical in character. As a practical expedient we have committed this task to a stand-alone program that can be used by a clerk-typist; this frees professional personnel from the most time-consuming aspect of the implementation process. This program is now operational.

Accomplishments during the reporting period which relate to laboratory support software development:

- Completion of the LSPEC program.
- Improved interface between component programs of the system.
- Improvements in LIS in the areas of display specification and table organization.

#### Management and Analysis of Data and Text

CCBS efforts in data management and analysis are focused on forms of interactive data analysis that will allow a substantive expert (the researcher, the policy-maker, the policy-analyst, the decision-maker, etc.) to exercise his judgment in the course of the analytic process. The principal efforts in this direction are the TRACE and IDEA developments. In the area of text analysis, we are building an interactive recursive transition-network sentence analyzer. The latter is designed to augment standard content analysis of text with thematic or sentence-analysis components. The resulting Theme Encoding System (TES) is intended to provide a considerably more sensitive and less ambiguous analysis of verbal text materials.



TRACE--This is a highly general system of programs that produce the equivalent of an implicit programming system. Implicit programming is tantamount to "natural-interaction"--the user does not need to be explicitly concerned with data management; all data management is accomplished without direct specification. Functionally, this transforms the user into a data analyst technician without having to know or exercise data analysis computing techniques. The support that enables this sort of functional transformation is extensive and complex. TRACE is composed of three major components: a compiler that interacts with the user, a data-base management component that builds and updates the primary data structures; and a manipulative component that acts on the data structure to produce the desired results. (A description of the TRACE system is contained in P-2, TRACE: An Implicit Programming System for Inductive Data Analysis.)

The CCBS virtual memory developments afford a direct extension of the TRACE concepts; virtual memory extends the implicit programming capabilities to large data systems that exceed core memory limitations.

IDEA--The IDEA program offers an inductive aid to a researcher for discovering and summarizing potentially interesting data models in the form of restricted tree structures for a multivariate data base. It permits the investigator to collaborate with an open-ended library of programmed heuristics on the process of uncovering and representing the structure of his data.

The interactive aspect of IDEA is essential since the number of potential decision trees for any interesting set of data is too large to permit exhaustive search for

the best partitions, and the character of the data may be inconsistent with exhaustive search even if it were computationally possible. The program is thus designed to employ heuristics and to permit the investigator to monitor the process and to intercede when slavish application would produce artifactual results.

A fully interactive version of IDEA is available on the CCBS system. It is continually being modified with user experience and additional capabilities.

A revised version of "A Users Guide to IDEA in the CCBS System" has been completed. (CCBS-TM-24).

TES--Interactive Automatic Theme Encoding of Messages and Documents for Content Analysis. Progress in the area of automated language analysis has continued in recent years, with major attention turned away from such unmanageable tasks as fully automatic high quality language translation to the development of more sophisticated syntactic and lexical techniques for other applications. These techniques may be employed to meet the need for more efficient analysis of verbal interaction data that are collected in experimental gaming, social interaction, and simulation studies or for analysis of documents. For the most part, such data are either superficially analyzed by such computer programs as the General Inquirer, or great sums of time and money are spent in having them more deeply analyzed by trained coders. There is good reason to think that for the task of theme encoding the corresponding performance figures can be improved significantly by the development of a thematic parser of the augmented transition-network type that operates in an interactive mode. Details of the approach are described in the last technical report and in CCBS-TM-18.

Accomplishments during this reporting period in the area of interactive data analysis:

- Checkout of major portions of the TRACE compiler.
- The grammatical analyzer, the largest single component of TES has been coded, and 95% of formational errors have been eliminated by debugging.

### Laboratory Facilities

Housing for the CCBS computer-based laboratory has been developed on the U.C.L.A. campus. A facility of approximately 6,000 square feet provides space for the computer, laboratory, and staff offices. The laboratory is being outfitted for operations. In addition to the computer and interaction terminals, the laboratory requires other equipment (for monitoring, recording, stimulus presentation, and information exchange) in order to provide adequate facilities for a wide range of behavioral investigation. A closed-circuit T.V. system, an audio monitoring/recording system, and a general control system have been acquired and are being integrated into the computer-based laboratory.

### Video System

The video system consists of a closed circuit television camera and monitor in each of the 24 experimental cubicles, video recorders, mixers, patch panels, special effects generators, and other equipment. The video system will provide for remote visual observation of subjects, recording of subjects' gross behavior, and presentation of training and stimulus information.

### Audio System

In addition to the audio channel of the video system, independent audio capabilities are required, consisting of a speaker in each experimental cubicle connected through a patch panel to a central public-address type system.

This laboratory equipment has been acquired and is being installed. The laboratory will be fully operational in late Summer 1972.

Accomplishments during this reporting period in the area of physical developments:

- Acquisition and installation of laboratory equipment.
- Completion and occupancy of laboratory area.

## Simulation Research and Methodology Development

Laboratory simulation exercises are being conducted at a number of centers for the study of international relations, for evaluation of political-military strategy for crises and long range planning, and for study of other allied topics. One of two divergent approaches are characteristically used in these gaming efforts. In policy-oriented gaming, where credibility and realism are emphasized, data are not systematically recorded and analyzed, methodologies employed are typically unevaluated, and experimental control is deemed unnecessary except for constraining player departures from realism or the gamer's intended focus. In research-oriented gaming, where theoretical and methodological issues are of primary concern, superficial representation of reality and the use of unskilled players have led to extensive criticism and charges of triviality. In either case, because these games are administered, played, and observed manually\*, they are severely limited in the amount and subtlety of monitoring and control, in the level of detail and volume of data that can be gathered, and in the role played by the analysis of these data. Furthermore, where the complexity of situations being studied does not readily yield to the control sought in the standard application of the laboratory experiment--a situation characteristic of almost all laboratory gaming--these limitations in control or data gathering greatly curtail the value of these exercises for evaluation or research purposes. Consequently, whether policy- or research-oriented, such games are unable to deal with a number of important questions, some of which are so fundamental as to bear on the validity of the games themselves.

Our research plan attempts to join the assets in both approaches and to reduce a number of the limitations associated with each.

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\* In almost all so-called man-machine exercises, the computer serves as little more than a rapid desk calculator rather than as an on-line tool to improve the data collection and dissemination processes.

In particular, an attempt is being made to realize jointly the objectives of the theory-oriented researcher, and the more stringent demands for credibility and relevance of the policy-oriented practitioner, through our newly-developed on-line capabilities. Furthermore, through a strategy of overlapping data linkages with non-simulation approaches, we hope to increase the generalizability and utility of simulation studies and data.

In our program of research, we continue efforts that are directed toward a number of related goals: 1) Determination and study of issues which are simultaneously important issues in U.S. foreign policy and which are amenable to theoretical and research analysis that may be applied in a simulation setting, 2) development of computer and associated simulation methodologies for laboratory exercises, 3) development of computer simulation submodels of international processes based on the theory and data generated in the laboratory simulation studies and from real world data bank studies, 4) experimental and para-laboratory studies of human behavior in situational conflict, and 5) incorporation of real world data and on-line data and management techniques to help specify variables and control activities in the simulation setting. Project activities during the past six months have been undertaken and are described in all of the above-listed areas except under items "3" and "5". The latter will be initiated when the TRACE-III system is operational.

#### Scenario Topics, Conceptual Issues, and Scenario Developments

Proposed and developed simulation scenarios will continue to focus on some of the central issues of American foreign policy today--the factors influencing the degree, form and effectiveness of U.S.-U.S.S.R. involvement in local conflict.

A key problem of the United States foreign policy in the next decade will be the extent to which the United States can, in future crises, take actions that are commensurate with its conventional and nuclear power, its economic strength, its scientific

and technological status, and its interests in the outcome of the crisis. We are concerned with studying the factors which permit or constrain the United States and the Soviet Union from taking action in a set of representative crisis situations.

### Conceptual Framework for Simulation Scenarios

While pursuing the detailed development of particular scenarios we are attempting to set forth conceptual frameworks that raise questions about the dynamics of great power involvement. Most particularly we are concerned with the dynamics of confrontation and commitment processes in these circumstances. The evolving framework and hypotheses of interest are being used to shape scenarios and the simulation format as much as possible without compromising their policy-validity and their utility for policy analysis. Two areas have been singled out for attention:

**Confrontation Theory: A Theoretical Framework.** In exploring the field of deterrence theory as it relates to U.S. involved crises in the third-world area, we began by reviewing case studies of what has happened in earlier crises (Korea, Quemoy, Vietnam). This led us to the formulation of a number of general questions designed to help us explore the conditions of successful and unsuccessful deterrence and led to the development of a new conceptualization of "Confrontation Theory: Introduction" by Professor David Wilkinson and other members of the simulation project staff. In summary, confrontation theory includes initiation theory (accounting for an Act--or its omission), response theory (explaining a Counter-act--or a failure to Counteract), and outcome theory (explaining the result of a confrontation). This effort was reported in an earlier technical report and in a document cited in that report. Laboratory studies based on this framework will be initiated after the move to the laboratory facility is completed.

**The Role of Commitment Processes in Defining Foreign Policy.** The current phase of this effort is concerned primarily with testing two hypothesis sets on military commitments reported in the last

technical report. These hypothesis sets deal with two aspects of commitments: perceptions of commitment credibility and a defender's willingness to increase the credibility of his commitment in situations in which he perceives it as not being fully credible to the challenger.

This testing phase consists of two stages: pilot runs designed to perfect the testing materials and procedures followed by the actual testing itself. We are currently in the first stage.

For testing the commitment hypotheses, we are using the SCENQUEST\* technique: a paper and pencil exercise consisting of questions based upon a written scenario. See earlier technical reports for a more detailed description of this technique. The testing package consists of three elements: 1) an instruction sheet, 2) the "scenario" itself consisting of background materials leading up to a future Middle East crisis and an intelligence report in which the variables specified in the hypotheses have been operationalized in the form of one or more paragraphs of text designed for modular incorporation. By systematically modifying the paragraph modules, different combinations of variables may be introduced; finally, 3) the questionnaire itself attempts to assess the respondent's interpretation and response to the situation presented. There are two separate test packages for the two hypothesis sets. One package consists of scenario and questionnaire for players simulating Egyptian, Israeli and Soviet roles and is designed to test their perceptions of the credibility of the United States commitment. The other package consists of scenarios and questionnaires for U.S. players and is designed to test their willingness to strengthen the credibility of the U.S. commitment.

In the pilot runs, we have been attempting to perfect the testing packages in several ways: formulating maximally independent operationalization of variables and clearing up problems of unintended differential saliency and bias in the operationalization of the independent variables and in the questionnaire.

\* See page 30.

Another interesting problem is that involved in determining which variables to manipulate, which to hold constant, and which to allow to randomly vary across experimental treatments. With as many as ten variables, the representation of the Boolean combinations of variable levels would result in more than a few thousand distinct configurations. Not only would such an experimental design lead to impossibly difficult interpretations, but the preparation of distinct version of printed materials to represent these unique combinations would create a logistic and typing problem of nightmarish proportions. The computer will be enlisted to solve this problem by providing it with specification for partial designs--of independent variables, nested variables, non-manipulated variables with fixed values, and non-manipulated variables whose effects are randomized across conditions. In this way the appropriate stimulus requirements for any particular design can be precisely defined and the computer will be used to prepare the distinct versions of printed materials for each subject as hard copy printouts.

#### Methodology for Scenario Design and Construction for International Relations Simulation Exercises

Although simulation games are finding wider usage (in universities and military colleges, as well as in political-military exercises), practically nothing has been written on how to prepare good scenarios, nor have any systematic procedures been developed to assist the scenario designer in organizing information, materials and concepts. Scenario design remains an art in which only few practitioners achieve products of high quality. As a consequence, most scenarios are designed on a hit-or-miss basis and are excessively costly; the implications for playability, representativeness, and relevance to theory and policy concerns are left to intuitive decision.

The purpose of the planned book will be to provide general and specific guidance on scenario development for study of international crises so as to contribute to an improved quality and economy of gaming. The book also will serve as a manual on how to conduct simulations, of procedures, record keeping, control problems, role playing, debriefing, etc.



During the course of our discussions on this effort, we have been led to place increased emphasis on the value of constructing a simulation exercise as an important teaching and learning device. In order to construct a simulation, the student and designer must go through a detailed and exhaustive series of steps which require that he make very explicit assumptions about the nature of the international system. He must translate these assumptions into the construction of an alternative world description, and a crisis scenario, in ways that are logical and internally consistent. He must clearly sort out the presumed role of the many variables he has identified, and he must be clear about the purposes and expectations he is associating with the exercise he is creating. This is precisely the intellectual process the authors of the book have found themselves immersed in, and it became increasingly clear as work progressed that readers of the book should be given a similar opportunity to go through this process, since it is of great value as an aid to clear thinking about one's own views of the international relations process that enter into the scenario construction. Accordingly, many of the chapters in the book will go well beyond their original conceptual structure. In addition to providing instructions to the reader on how to proceed in the construction of a simulation exercise, and examples of exercise materials, we will attempt to explicate the step-by-step intellectual process which led us to make certain choices and assumptions, and we will provide the framework for the reader to move through a similar process on his own.

A draft chapter entitled "Alternative International Context for Policy Gaming" (CCBS-TM-33) illustrates one approach explored in our work group to realize this goal. This paper presents some guidelines for the game designer concerned with constructing an international contextual description as the background setting for a crisis scenario in a political/military game. Ten essential elements of an ICD (world power distribution, world conflict structure, international economic conditions, international psychological climate, system rules, demography, ecology, political stability, national capability profiles, national foreign policy objectives)

plus seven less important elements are identified, summarized, broken into their components, applied to the world situation in 1972 and to a hypothetical world situation of 1990, and analyzed for their relevance. A step-by-step guide for moving from the selected research topic to a full-fleshed ICD by using the ten essential elements is appended.

The outline of the book has gone through a process of revision as the organizing concepts of the book continue to evolve and crystallize. The initial framework has been augmented to focus on the core political interaction. There are now five main parts to the book outline. Part I will be an introductory section dealing with the purpose of simulation exercises, and their role in the study of international relations. The next two parts are concerned with the creation of situational structures within alternative world environments. This includes both an emphasis upon the static and dynamic aspects of international cooperation/conflict crisis settings and an emphasis upon longer run variables and conditions of the world environment within which the specific crisis interaction occurs. The fourth part goes into practical aspects of game design and operation with the aim of assisting the simulator in effectively obtaining the desired experimental setting. The last part gives concrete illustrations of the theoretical and practical suggestions contained within the previous four sections.

A major development during the preceding period has been the introduction of the metagame approach suggested by Nigel Howard<sup>\*</sup> and its modification for the analysis and design of crisis situations. At present this approach is being explored in conjunction with the transformation of real world materials into tractable scenario elements as well as the analysis of existing scenarios and expert situational definitions to produce a greater amount of simulator control and understanding of the generated setting. Some modifications

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<sup>\*</sup> See Howard, Nigel. Games, Metagames and Rationality. Cambridge, Mass.: MIT Press, 1971.

are necessary to make this general analytical approach into a useful design technique, and a preliminary report illustrates the specific problems and suggestions. (CCBS-TM-34). In this report the metagame analysis technique is explained and basic concepts defined and illustrated by the application of the technique to an existing Mid-East simulation scenario. It describes metagame analysis as a formal technique for the structuring of subjective definitions of situations; the method, itself, in no way prejudices the result of the analysis. The outcome is the result of the author's assumptions concerning the situation. Different assumptions result in a different outcome. The report is intended to show how the metagame analysis technique can be used to structure the crisis focus of a scenario, and suggests certain tentative process hypotheses.

#### A 1976 Mid-East Scenario for a One-Team Simulation Exercise

The general purpose in developing a one-team simulation is to create an international relations game which requires only limited personnel for administration, and affords greater control for research purposes. It is an effort to provide a simulation format that offers greater efficiency, control, and standardization; this is the rationale for reducing the response roles to a single team, the U.S., while all other nation roles in the game are simulated. Not only can a number of U.S. teams be run simultaneously, but the physical presence of a number of teams adds to the credibility that these other teams are being played "live" rather than being simulated by the experimenter.

The first scenario developed for the one-team format explores deterrence and commitment considerations that would motivate an American decision to give large-scale direct military assistance to Israel under conditions of increasing levels of Arab-Soviet endangerment of Israel. The question of substantive policy interest is whether players will accept the consequences of one of the pure strategies (commitment or non-involvement) or be drawn to compromise

alternatives (some level of partial commitment with attendant partial involvement) which are psychologically attractive, but may be strategically poor in a series of escalation moves. See the last technical report for a description of the policy research purposes of the scenario and CCBS-TM-28 for the complete scenario.

In addition to the methodological and policy focus, questions of a more social psychological nature are also being formulated for this simulation exercise. There is now a sizeable and controversial research literature\* that groups of individuals take more risks than would the same individuals making the decisions privately. A number of dimensions that influence such shifts in choice will be systematically varied to determine the extent to which they would influence the decisions made to the Middle East scenario. Special attention is being given to variables that would appear to exert an influence on decision recommendations among high-level advisory staff.

Pilot runs of the game have been conducted successfully in a manual semicomputer mode, and programming the simulation for computer administration has been completed with a revised version of the pre-game scenario and game moves. Laboratory runs on the computer will be initiated during the next reporting period.

#### Direct Validity Tests of the Stanford General Inquirer.

With the likelihood of a revival of interest in computer content analysis studies resulting from improved methodology, the problem of assessing the validity of computer content analysis methods requires more serious attention than it has received in the past. Although somewhat more complicated, the validity problem in this area is not fundamentally different from

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\*Pruitt, D. G. Choice Shifts in Group Discussion: An Introduction Review. Journal of Personality and Social Psychology, 1971, 20, 339-360. This number of the journal is a special issue devoted to risky shift and contains a number of research reports on this topic.

that of assessing the validity of any measuring instrument. Does it measure what it purports to measure?

Attempts to establish validity are of two kinds. Construct (direct) validity is afforded by determining how well estimates using the instrument compare with alternative means of measuring the same phenomena. Thus a new IQ test might be compared with other measures or teachers' ratings of intelligence. Predictive validity attempts to assess an instrument by inferring its validity indirectly by examining its hypothesized relationships with other variables. A good measure will normally exhibit both forms of validity. It is thus surprising that although the Stanford General Inquirer has been extensively used in the analysis of political documents, there is not a single published report that indicates whether the inferences based on the three semantic differential scales used to describe national actors and their behavior conform to similar characterizations obtained by other means. Instead, validity of these scales has been inferred indirectly from hypothesized relationships of the semantic differential categories to other variables. Since reported relationships are not impressively high nor uniformly obtained, there is an obvious need for some simple, direct assessments of validity of the Stanford General Inquirer. A series of simple experimental tests are planned to get at the validity of the techniques by systematically exposing errors which may occur at various stages in the content analysis procedures.

Initially, global assessment of validity will be made. Subjects will be presented with paper-and-pencil descriptions of situations involving a number of nations in well-defined conflicts or crises. Nation descriptions will be systematically differentiated in terms of attributes and behavior that would presumably lead to differential characterization along the evaluative, potency and activity dimensions. Subjects will then be asked to assume the roles of statesmen and/or advisors to one of these different

nations and to compose a variety of messages consistent with the information provided. Validity will be assessed by determining how successfully the Stanford General Inquirer will be able to reconstruct actor action and target characterizations consistent with the specific information sets provided subjects. Beyond this general comparison the analysis will also attempt to determine whether the content analysis is done equally well for the three different scales; for actor, action and target units and whether different kinds of messages will be better or poorer vehicles for assessing scale information. Still at a general level, but viewing the messages from the standpoint of the recipient or policy analyst, to what extent will "natural" readings of the messages be consistent with the set of implications drawn forth by the computer analysis. To be sure, these are basic, general questions, but there is no information available of even this elementary kind.

At a more analytical level, to what extent does the semantic differential signification of a given sign depend on linguistic context? Are there general contextual determinants that can be identified, corrected, weighted, ignored? Are there more useful or appropriate grammatical parsings?

The potential questions are, of course, endless and a strategy of evaluation must be designed that is both economical and which moves rapidly to detect the major contributions to validity and error variance.

The analyses are still at the planning stage, but it is quite clear that they can be undertaken with minimal cost and effort. At the same time it is expected they would serve two major purposes of considerable importance: 1) The results would provide a much needed and long-overdue direct assessment of the validity of the content analysis procedures, and 2) the approach would initiate a more differentiated response to the

detection and analysis of the various stages in content analysis at which error may occur. The identification of these points in the analysis process where validity is lost would also provide specific requirements for our project on computer interactive theme encoding of verbal documents.

Thematic and instructional material for the first phase of this study has been prepared for pilot studies and experimentation. With the availability of the laboratory, these studies will be initiated during the next reporting period.

#### Experimental and Para-laboratory Research Studies of Human Behavior in Situational Conflict.

The simulation approach, because of its complexity, particularly needs to be closely interrelated at many levels with other techniques of investigation to clarify its findings, to serve as a direct source of hypotheses, and as a simple setting for developing and testing new methods. It is necessary, then, that the research program continue to range widely in its approaches to problems from paper-and-pencil situations to computer-based experimentation and that data from these studies be more closely linked. While these studies are only a small part of the total effort, we believe it is particularly important to continue two lines of investigation in support of the simulation activities: 1) our earlier program of experimental studies in the new computer laboratory, and 2) SCENQUEST studies.

While no new experimental studies are being undertaken until the next reporting period when the laboratory is available, results of earlier studies continue to be analyzed and reported.

SCENQUEST - A Scenario Questionnaire Technique for Studying In-process Phenomena in Conflict Resolution.

Many in-process phenomena cannot be studied easily in simulation exercises because they occur rarely, or follow unique patterns

of antecedent events, or require more extensive subjective analysis than can be easily obtained during the exercise. The SCENQUEST approach, based on a combination of standard techniques, affords the laboratory investigator a convenient, low-cost means of collecting data on a wide variety of situations that require control and standardization of antecedent events. An example of such a situation is a player's sudden shift to aggressive moves in a condition that had been stable and characterized by cooperation, and where no outside triggering event could be detected.

In the SCENQUEST approach, the experimental subject is given a specific opening or ongoing situation or game. The synopsis is in dramatic, real-life terms or in bare-bone, analytical ones, and may concern situations as complex as those presented in simulation scenarios or as simple as those in a prisoner's dilemma experiment. The synopsis may give a summary history of the events and decisions made by both parties up to a given point. The subject reads the scenario from the point of view of one party in the situation; he is then asked to respond as if he were in the situation with the history as it is given and in the designated party's place. He then records his response on a questionnaire form. This procedure contrasts with role-playing where a person is asked to adopt another's attitudes, opinions, etc. The respondent here is situation-playing.

**Determinants of Size of Conflict.** An ongoing SCENQUEST study explores a number of determinants of the perceived size of conflict at the opening phase of an experimental bargaining situation. Variables identified for analysis include size of stake in the bargaining, divisibility of issues into separable bargaining units, amount of opportunity for exchange of bargaining offers within a negotiation encounter, number of negotiation encounters, and degree of inequality of trial outcomes (relatively equal to vs. highly unequal potential division). Game materials, instructions and recording forms were developed for these variations in a  $2^5$  experimental design. A set of 57 dependent measures and 26 derived measures were used to assess



the effects of the independent variables on earning goals, strategic and tactical planning and on self and other bargainer perceptions. Data collection for 300 subjects was completed. These data have been augmented by data on 160 subjects collected by a colleague in Israel. The results appear to be unusually promising in separating out factors that contribute to a global, effective orientation to negotiation versus a strategic orientation to the variety of negotiation situations presented. Preliminary findings were reported in the last two technical reports and in a paper on "The Effects of Size of Payoff and Real Versus Imaginary Rewards on Pre-Bargaining Perceptions" accepted for presentation at the American Psychological Association Meetings at Hawaii.

A second SCENQUEST study has been incorporated as part of the Los Angeles Metropolitan Area Survey conducted by the U.C.L.A. Survey Research Center. At the closing phase of a structured interview, the respondent is presented with a conflict-of-interest situation with an automobile dealer and is asked to imagine what he would do in the situation.

Two variables are studied. 1) The effect of same versus different ethnicity of salesman and respondent. (The scenario describes the salesman as "Mr. Brown, a Negro", "Mr. Goldstein, a Jewish salesman", "Mr. Lopez, a Mexican-American"). 2) The effect of a firm or a flexible concession.

Data is collected on the respondent's perception and choice of influence tactics. (See the last technical report for a more complete description of this study.)

The data collection on more than 1,000 respondents has been completed; however, the Survey Center has made an error in the sampling design that will limit the value of these data. Either a refund of charges or another set of data will be collected without additional cost.

A third SCENQUEST study has been made of misperception or bias of participants versus observers under varied conditions of incentive and ability to influence outcomes.

The U.S. and North Vietnam are active participants in the Vietnam conflict with a vast difference in ability for directly influencing the outcome of the conflict. Another group of nations who are not directly involved, nevertheless will lose or benefit directly with the outcome. Finally, other nations have little direct involvement with the outcomes but are "neutral" observers. The questions posed in this study is the effects of these different kinds of involvement on the perceptions of a conflict situation and on the attributed motivations of the directly involved actor.

A popular social psychology theory during the 1960's was dissonance theory, which assumes that man's aim, in making social perceptions, is to rationalize his "driven" behaviors and to perceive himself as acting consistently. Biases in social perceptions were assumed to result from this tendency to reduce dissonance, a motivation aroused when the individual perceives himself as acting inconsistently. The 1970's ushered in attribution "theory", which makes different assumptions from those of dissonance theory. This new approach assumes that man seeks only to perceive his social environment accurately. Biases in social perception are assumed to stem from the fact that man must make situational inferences on the basis of limited information. Thus, biased social perceptions are considered by attribution theorists to be errors in information selection and processing rather than "need-oriented perceptions."

Much of the controversy between theorists of the two schools has centered around frequent differences which occur between the social perceptions of participant actors vs. uninvolved observers of action in the same situation. Dissonance theorists assume that actors are seeking to reduce the dissonance produced by their own behavioral inconsistencies, and to justify their behavior by their social perceptions. Since neutral observers have no action of their own to justify, they experience no dissonance, and make more "objective" perceptions. Attribution theorists on the other hand assume that different historical information, causal information, and information on consequences is typically available to

actors vs. observers, and that inferences based on these different sources of information lead to different social perceptions, even in the same situation.

The present study proposes a third model of social perception processes. Our instrumental learning model considers human cognizing--including the processes of making social perceptions--to be itself a form of behavior. As such, social perceptions are assumed to be controlled both by environmental stimuli which signify to the perceiver the types of outcomes likely to follow certain courses of action, and by the reinforcing consequences of the perceptions made. We hypothesize that, where an individual's future outcomes are a salient concern to him in perceiving his situation, the individual's discrimination as to whether or not he has power to affect his outcomes is an important determinant of whether he has an incentive to make a strictly accuracy-oriented perceptual response (as predicted by attribution theory) vs. whether he "rationalizes" in perceiving the situation (as hypothesized by dissonance theory.) It is assumed that accuracy-oriented perceptions have instrumental value to the individual whose behavioral choices affect his outcomes, whereas they have little value to the powerless person. The powerless person may then "rationalize" his situation in order to feel better about it.

We assume, then, that differences between actors' and observers' social perceptions are complexly determined by the outcomes which they hope to attain from the situation, by their abilities to affect those outcomes, and by the need of actors to justify certain actions they may take in order to achieve the outcomes they desire. A suggested study to test the importance of these variables is being designed. Identical information about a bargaining situation will be presented to actors and observers in different conditions. Patterns of social perceptions as a function of the above-mentioned variables will be investigated.

The approach suggested in this study not only attempts to test when the assumptions of each of these social psychological approaches most accurately describe social perception processes, but also draws from and suggests extensions of mass society theory, a theory of major importance in the field of sociology. For example, the approach developed in this study suggests that the powerless or alienated actor not only learns less about his situation but also distorts it in particular directions. If confirmed, the approach will offer some fresh interpretation of bargainer misperceptions associated with his relative power to influence his outcomes.

The data for 120 subjects has been collected and is in the process of final analysis prior to write-up.

## FUTURE PLANS

This section reviews our plans to accomplish the program of research, as discussed in the project's original proposal, within the funding schedules negotiated as terms of the basic contract. As reflected in our previous management and fund status reports, we have discussed a potential need for revision of these terms; because of delays associated with equipment arrival and facilities completion, many of the project developments will come to greatest fruition in the last phase of the contract. At this time it is apparent that the project will realize its goals more adequately if the contract completion date is extended for one year so as to take maximum research use of supporting facilities that have been developed. Based on the proposed one year extension date of the contract, the projected plans for the Center focusing primarily on the next reporting period are the following:

### Central Computing System -- Hardware

The computer hardware to support Phase I operations is complete.

With the functional design complete, work on Phase II has continued with the detailed logic design for virtual memory hardware; fabrication of the hardware will be initiated the first quarter of fiscal year 1973. The hardware necessary for archive storage will also be acquired before the end of the fiscal year. A third component of Phase II capability concerns remote user support; specifications for hardware acquisition in this area have been deferred to insure compatibility and maximum performance in the context of the ARPA network; these requirements will be determined in coordination with our entry into the network.

### Central Computing System -- Software

Phase I software is complete; work in this area will be confined to maintenance and selective upgrading.

Phase II software development is, of course, dependent on the delivery of virtual memory hardware; with the functional design of that hardware finalized, formulation of the software design has begun; implementation is scheduled to be coincident with hardware checkout.

#### Higher-order Language

The complete JOVIAL compiler has been delivered and is being used in applications programming; the compiler will be extended and maintained under contract for the next eighteen months. The principle extensions will be the development of a JOVIAL language debugger (now in progress) and the inclusion of virtual storage capability (to take full advantage, at the programming level, of virtual memory hardware developments). The META compiler will be extended and upgraded with special emphasis on increasing its ease of use and extending its capabilities to reformat data bases.

#### Laboratory Facilities

The permanent laboratory is ready for operations. Equipment to outfit the laboratory has been specified and a major portion has been acquired; selected portions of the equipment will not be acquired until requirements can be more usefully defined in the context of operations.

#### Laboratory Software

A prototype of the laboratory programming system is operational and is being empirically tested; the results thus far have substantiated the basic design concept; the development strategy is an incremental one which means that, beyond the basic capability, needs are being defined by operational demand; this process of upgrading will be continual, but the activity will be greatest when the system is initially exercised in the context of operations, i.e. during the next six- to twelve-month period.

### Data Analysis/Management System

Separate components of the TRACE system are essentially complete-- SMART has been checked out; an initial version of the TRACE interpreter is operational; and the TRACE compiler is far into the check-out phase. Integration of the components and system check-out is expected during the first quarter of fiscal year 1973. Subsequent to the system check-out, the SMART function will be replaced by the implementation of virtual memory hardware, and the SMART compiler will be more effectively interfaced with user language requirements.

### TES--Computer-Assisted Interactive Theme-Encoding of Texts for Content Analysis

A JOVIAL '70 version of an augmented recursive transition-network sentence analyzer has been programmed and is now being debugged. Dynamic debugging of the operational analyzer is ready to begin at the time of this report. Recent improvements in CCBS hardware and software facilities should allow the slight slippage in the original schedule to be regained. Experience with test runs of the analyzer will provide the basis for development of the interactive facilities of the theme-encoding system.

### A Book on Scenario Design and Construction for International Relations Simulation Exercises.

Writing of chapters on the text will occur at an accelerated rate during the next year as a result of fundamental conceptual analysis and clarification of the role of political-military exercise methodology.

### Formulation of a Set of Simulation-Testable Propositions in Confrontation and Commitment Theory

With the completion of papers in both of these areas, plans for testing subsets of variables have been evaluated for simulation testing. Laboratory implementation will be initiated during the next quarter in the new laboratory facility. The pilot data collection phase of a SCENQUEST study on the evaluation of variables influencing credibility of commitment is largely completed and data collection will be undertaken during the next reporting period.

### A Mid-East Scenario for 1974 for a One-Team Simulation Exercise

The one-team simulation has been programmed for computer administration. Shake-down runs have been completed; preliminary data have been used to revise and expand the scenario and associated techniques for on-line elicitation of decisions and responses. Both policy questions and theoretical hypothesis on individual and group decision-makers will be explored in a series of experimental runs to be initiated during the next reporting period in the CCBS laboratory.

### Direct Validity Tests of the Stanford General Inquirer

With the availability of the CCBS laboratory and the General Inquirer IV and the Stanford Dictionary, experimental validity studies of the kind described will be initiated during the next reporting period and analyzable results will be available at approximately the end of the next reporting period.

### Experimentation

Analyses of data from earlier computer laboratory-based experiments will continue and results will be reported. With the availability of the CCBS laboratory plans for experiments will be initiated and used as test cases for the "entry" module of the laboratory software system.

### SCENQUEST - Scenario Questionnaire Studies

Additional write-ups of the Size of Conflict study are in preparation. New data made available from Israel will be analyzed and cross-cultural analysis will be in comparisons of these data with our own and those collected by investigators in France.

Bargaining data collected by the U.C.L.A. Survey Research Center has been shown to contain a sampling design error. As a result only limited analysis of these results are possible. Either new data will be provided without additional charges or refunds of charges will be made.



Data collection on bargainer misperception and bias under varied conditions of incentive and ability to influence outcomes was completed during this period. Write-up of results from this study will be largely completed during the next reporting period.

## PROFESSIONAL AND PROJECT-RELATED ACTIVITIES

### Dr. Shure's trips, lectures, etc.

Attended California State Psychology Association Meeting, Los Angeles, January 28, 1972.

Ohio State University, Columbus, to participate in conference at Mershon Center on the transfer of knowledge into policy. To meet with members of the International Relations Committee of SPSSI to discuss ACDA proposal for behavioral science recommendations. To visit the Behavioral Studies Laboratory and meet with laboratory personnel. February 4-6.

Lecture and demonstration at ISA meeting in Dallas, Texas, March 15-17.

Lecture at the University of Texas, Houston, March 20.

Presented paper at the Interdisciplinary Colloquia on Mathematics in the Behavioral Sciences, UCLA, April 7.

Lecture on Interactive Computing for Social Scientists, USC, April 20.

Demonstration and lecture at CACI/CCBS/ARPA Utilization Conference, Airlie House, Virginia, May 3-5.

Pre-planning Conference on Health Survey Reference Index Project, Pacific Palisades, May 25.

## Visitors to CCBS

David Vernon, University of Michigan, January 2, 1972.

Al DeLucia, RADC, January 4.

Professor Sarane Boocock, USC, January 7.

Dr. Norman Dalkey, Rand Corporation, January 20.

Commander James Roby Smith, U.S. Navy, Ft. Belvoir, Virginia, January 24.

Dr. Edward DeLand, Rand Corporation, January 31.

Dr. George Miller, President, SDC, February 1.

Dr. Richard Chadwick, University of Hawaii, February 16.

Dr. Tom O'Sullivan of Raytheon, February 25.

Dr. Norris, Mr. Miller and Mr. Homer Hagedorn of A. D. Little & Co., March 23, 1972.

Dr. Donald Drukey, March 23.

Capt. Al Wilhite, I.C.A.F., March 23.

Dr. Philip Stone, Harvard University, March 28.

Professor Moshe Rubinstein, Chairman, Dept. of Engineering Systems, UCLA, March 28.

Professor James Kahan, USC, March 28.

Pat Langendorf, RADC, March 29, 30, 31 and April 3.

Dr. Edward DeLand, Rand Corporation, March 31.

Professor James Deese, Johns Hopkins University, April 7.

Dr. Tom O'Sullivan of Raytheon, April 11. Discussed ARPA network utilization for C.A.C.I.

Dr. Nancy Ward, Los Angeles County, May 9.

Dr. George Lawrence, ARPA, May 15.

Dr. Thelma Moss, UCLA, May 15.

Dr. Barry Boelin, Rand Corporation, May 19.

Colonel Austin Kibbler, May 22-23.

Professor Philip Stone, Harvard University, May 30.

Dr. Martin Kay, Rand Corporation, June 3.

Dr. Jack Naar, Naval War College, Rhode Island, June 14.

Professor Michael Leavitt, University of Wisconsin, June 19.

Mr. Ted Rubin, C.A.C.I., Santa Barbara, June 21.

Colonel Dettmer, RADC, June 30.

Project Documentation, January - June 1972

CCBS-TM-29 Functional Description of Virtual Memory Operation  
for the PDP-10 KA10 CPU, Louis Gallenson and Alvin S.  
Cooperband.

CCBS-TM-30 Crash Procedure, Barton L. Jones.